CITY OF KNOXVILLE

Mayor's Climate Council
Energy & Buildings Meeting

September 8, 2020

Equity Working Group Update

Erin Rose, Three^3

Meaningfully Integrating Equity into Climate Action

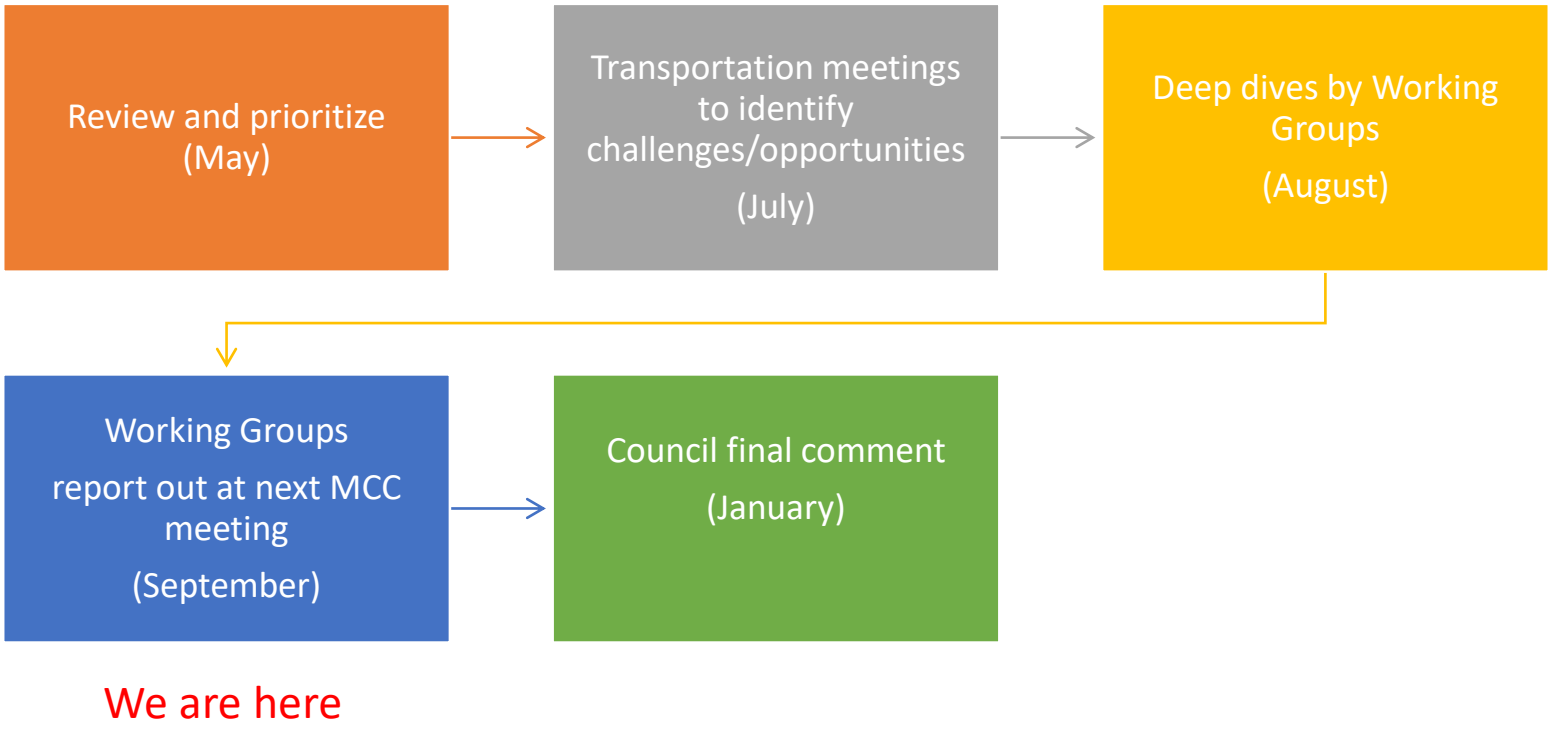
Equity in Process and Benefits

- Designing solutions
- Participation + Decision-making
- Implementation
- Monitoring + Evaluation
- Outcomes (measurable and subjective)

Informing Action

- Through EWG engagement of frontline communities
- Sharing collected information in advance of technical subcommittees
- Feedback on proposed climate strategies and their anticipated impacts on affected communities and groups
- Proposing indicators for monitoring and evaluation; signals for tracking burden + benefits over time

Meeting Flow



Transportation Working Group

- Met on Aug 11 from 1-3pm.
- 22 participants (excluding facilitators and Sustainability staff).
- Discussed strategies at a high level and heard feedback on additional considerations.
- Discussed definitions of impact: How do we define High, Low, Medium cost/impact/time?
- Follow-up survey asking for further ranking of strategies based on those definitions and any additional insights.
- We will host a follow-up working group call to debrief those findings.

Baseline Surveys

Surveys were used to

- Develop a better understanding of local priorities
- Identify critical working group members
- Develop early feedback on potential blindspots in strategies

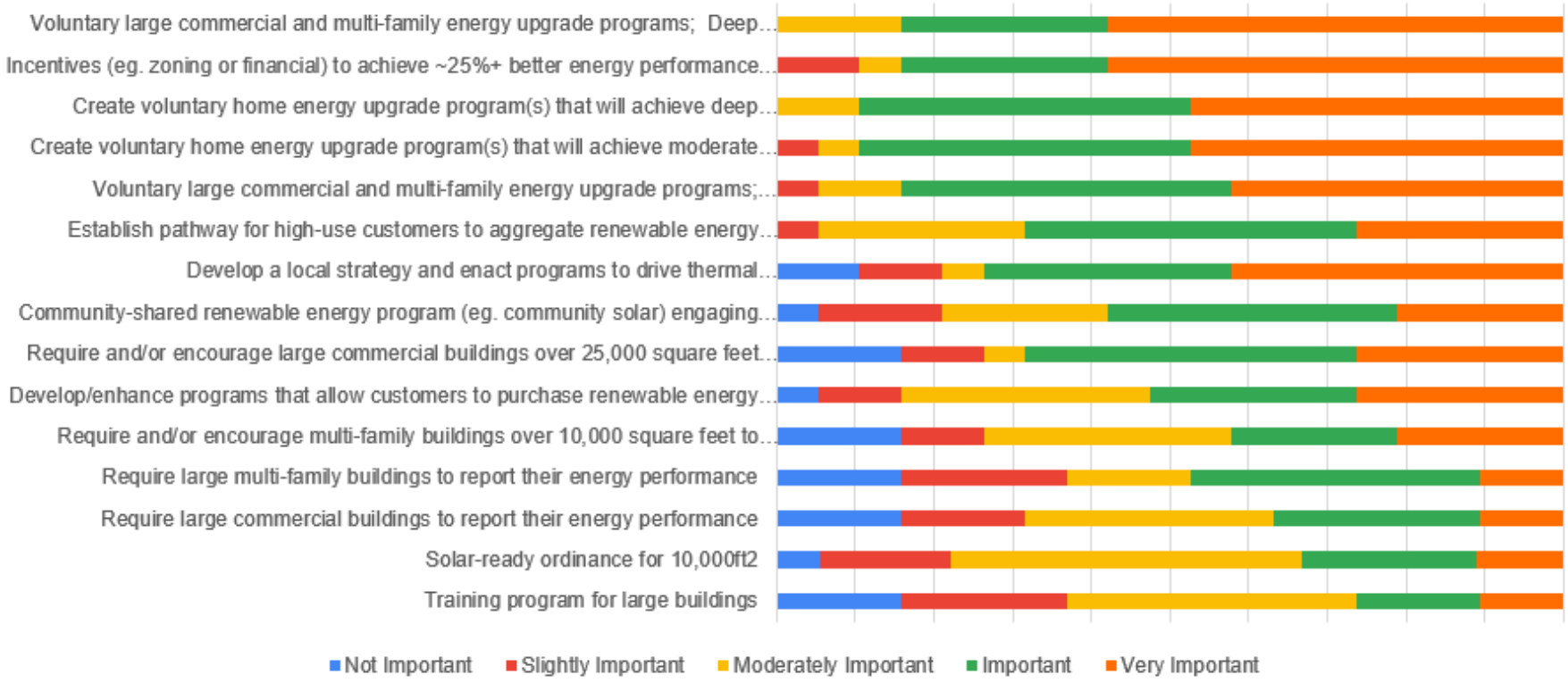
Surveys results are NOT

- A final ranking
- A commitment to specific phrasing
- A substitute for in-depth discussion

Baseline Rankings

- Create voluntary large commercial and multi-family energy upgrade program(s) (eg. incentives, technical assistance) that achieve deep energy savings (~25%+) in ~20%+ of large buildings
- Enact market incentives (eg. zoning or financial) that achieve ~25%+ better energy performance than existing local code in new building space
- Create voluntary home energy upgrade program(s) that will achieve deep energy savings (~25%+) in 20% of homes
- Create voluntary home energy upgrade program(s) that will achieve moderate energy savings (~10%+) in 40% of homes
- Create voluntary large commercial and multi-family energy upgrade program(s) (eg. incentives, technical assistance) that achieve moderate energy savings (~10%+) in ~50%+ of large buildings
- Develop a local strategy and enact programs to drive thermal decarbonization/electrification (eg. replacement of fossil fuel-fired furnaces, boilers, and domestic hot water systems with electric heat pump technologies or other renewable options) of existing buildings over time
- Establish a community-shared renewable energy program (eg. community solar) at a scale engaging ~5%+ of community members
- Require and/or encourage large commercial buildings over 25,000 square feet to conduct audits and/or retro-commissioning
- Develop/enhance programs that allow customers to purchase renewable energy through local utilities
- Require and/or encourage large multi-family buildings over 10,000 square feet to conduct audits and/or retro-commissioning
- Require large multi-family buildings to report their energy performance
- Require large commercial buildings to report their energy performance
- Adopt new ordinances or building codes to promote solar-ready construction in buildings over 10,000 square feet
- Develop a building staff training program with large privately-owned commercial and multi-family buildings and/or require building staff be trained in energy efficiency best practices

Ranking Insights



- Technical committee members placed higher importance on Market Incentives (#2) for better-than-code performance
- More strategies here were ranked as “Not Important” compared to transportation
- Common themes from MCC were concerns about impacting investment/property redevelopment by requiring more stringent requirements.


Questions?


Panel
Presentations

Technical Panels

Energy

Steve Seifried
Ameresco

Gil Hough
TenneSEIA

Buildings

Michael Davis
Sanders Pace Architecture

Joshua New
ORNL

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City of Knoxville

Mayor's Climate change Council – "Energy & Buildings 101"

September 8, 2020

Ameresco's Vision –

"Energizing a sustainable world."

Steve Seifried
Tennessee Solutions Executive
865-919-7785
sseifried@ameresco.com

AMERESCO
Green • Clean • Sustainable

ameresco.com

Vision: "Energizing a sustainable world."

Ameresco

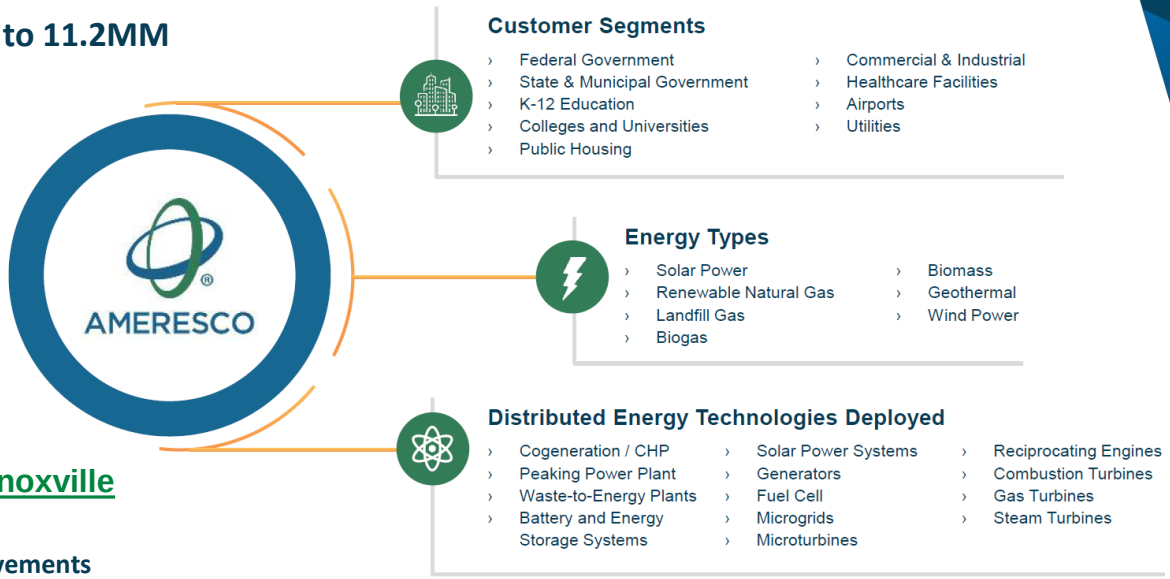
$8 Billion+ energy solutions

2019 carbon offsets equivalent to 11.2MM metric tons C02

1,000+ employees

8,000+ customers since 2000

Up to 45% savings energy costs to customer-partners



Ongoing Partnership w/City of Knoxville

2008 – current
Energy Management & Efficiency Improvements
Solar PV installation
Operations & Maintenance Support through 2024
Modeled Savings since 2012
Total of $12.016MM or $1.502MM average per year

Mayor's Climate Change Council

Dramatic changes and trends across Energy Sector

Federal and Public Sector Leadership

- Recent TVA paradigm shift …
- Research & Development

User Demands and Expectations

- Local Governments
- Higher Education
- Commercial & Industrial
- Residential

Bottom Line for many: Energy Creation + Savings = "Avoided Costs"

- Avoiding future cost increases, growth rates, and uncertainty
- Differing assumptions of "avoided costs" across industry … this is a big deal!

Other reasons … What is driving these changes/trends?

Outline of Presentation

"Energy & Buildings 101"

Sustainable Energy

Distributed Energy Resources

Advanced Energy Solutions

Value of Solar & Battery Storage

AMERESCO

Mayor's Climate Change Council

Sustainable Energy

PRODUCTION of energy that utilizes the sun, wind, waste, crops, etc. for its generation, not from fossil fuels (coal, oil, natural gas).

PRACTICE of USING energy in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Distributed Energy Resources

CENTRALIZED energy production versus **DISTRIBUTED**

Requires the application of Advanced Energy Solutions

May serve power needs of individual or subset of customers

- industrial facility, military base, college campus, downtown/commercial district

Mayor's Climate Change Council

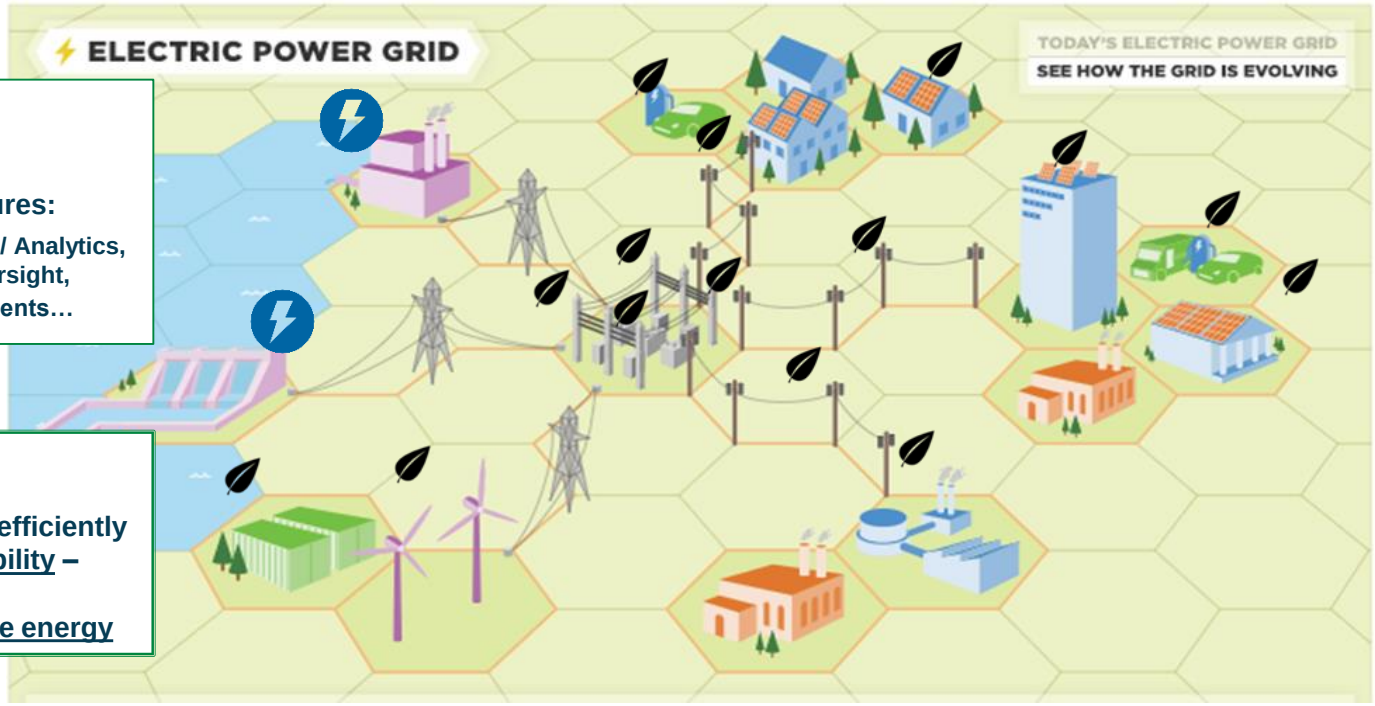
Distributed Energy Resources (DER)

Advanced Energy Solutions

- **Solar**
- **Battery Storage**
- **Energy Conservation Measures:**
  - **Energy Management Software / Analytics, Operations + Maintenance oversight, LED lighting, HVAC improvements…**

DER Goals

Aggregate & Optimize – connect disparate resources
Dispatch Energy – lower cost and efficiently
Provide Strong Resiliency & Reliability – at individual sites, overall
Integrate newly created sustainable energy



Mayor's Climate Change Council – "Energy & Buildings 101"

Assessing Value of Distributed Solar/Battery Storage

WIDELY RECOGNIZED and AGREED-UPON VALUE

- Avoided Energy Costs for Solar PV
- Lower Capital and Capacity Investments into Assets/Infrastructure
- Targeted Environmental Benefits

RECOGNIZED VALUE without INDUSTRY-WIDE CONSENSUS

- Targeted Environmental Benefits
- Economic Development benefits
- Reliability and Resiliency for customers and overall grid

PROVEN BENEFITS for Knoxville and many other Local Govts.

- How do we leverage past success into future impacts for City, Region, and beyond?
- Other Municipal experience from which to learn/apply to our region.

Technical Panels

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ORNL

Our Mission

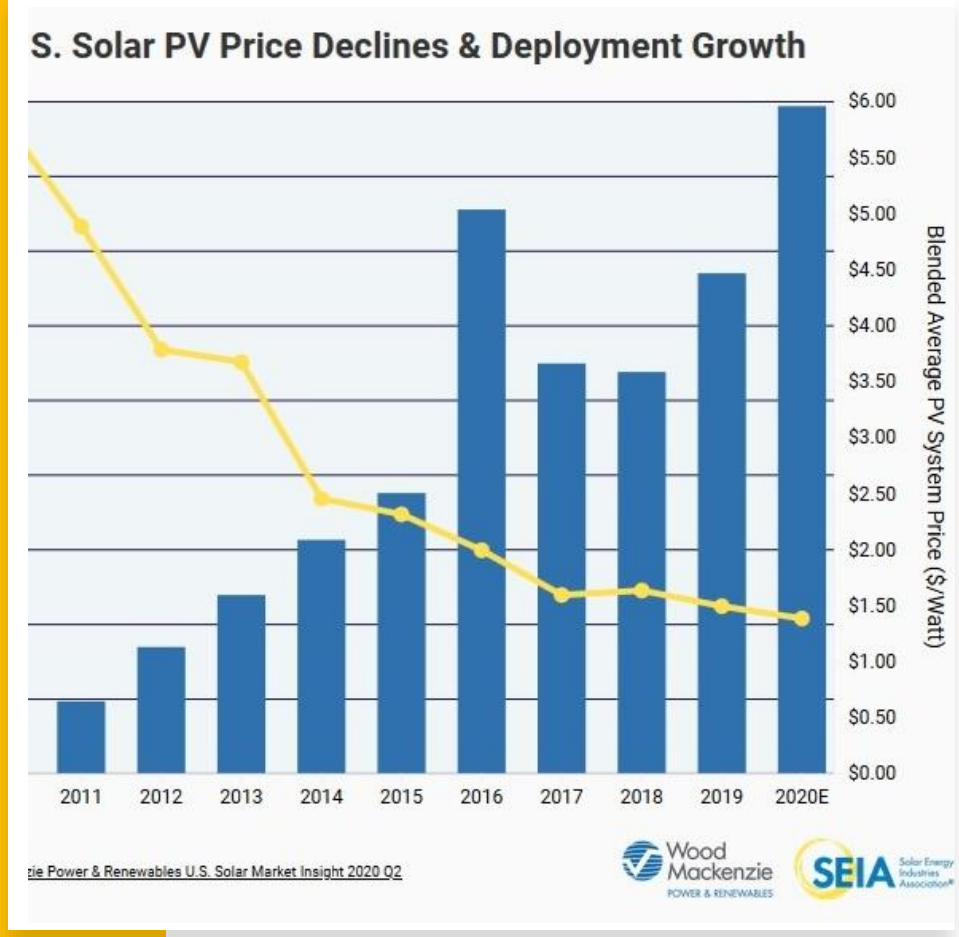
"Our mission is to promote the development of solar energy and complementary technologies, including storage, positioning the Tennessee Valley's residents and businesses as leaders in clean energy deployment and economic development."

- TenneSEIA Executive Committee & Board Members

TenneSEIA

Tennessee Solar Energy Industries Association

Gil Hough, Executive Director
September 8, 2020



Solar is now the low-cost energy choice

TVA has 1,500 MW solar operating or under contract

Storage is the game changer


THE
SOLAR+
DECADE

Solar Investments in the Region 2019

	Total solar investment
Alabama 282 MW	= $ 338.55 million, 614 jobs
Tennessee 429 MW	= $ 734.29 million, 4,690 jobs
Georgia 1,571 MW	= $ 2,210.67 million, 3,696 jobs
North Carolina 5,601 MW	= $ 8,129.34 million, 6,719 jobs
Kentucky 43 MW	= $ 76.78 million, 1,410 jobs
Mississippi 235 MW	= $ 274.94 million, 770 jobs

SEIA Solar Energy Industries Association®

Under their new contract KUB can offset at the TVA wholesale rate for 5% of their load (80 MW of solar).

So what should be KUB's solar goals be?

LEADERSHIP	Drive clean energy business development across a wide market range.
VALUE	Simple market drivers over complex bureaucratic programs
LEVERAGE	Existing incentives and understood business models to drive growth.

LEADERSHIP

A Collective Hats off to KUB Knoxville Utilities Board (KUB)

For negotiating a first-of-its-kind Local Power Company (LPC) Green Invest agreement with TVA to secure 212 MW of new-to-the-grid solar power for its customers!

This solar investment will generate an anticipated 465 million kilowatt-hours (kWh) of solar output per year, an amount equal to **8 percent of KUB's annual electric load**, or the equivalent of powering approximately 35,000 average homes.

I hope to see other LPCs duplicate this leadership!

New KUB pilot on Time Of Use (TOU)

VALUE

Residential TOU Rates Compared to Existing Rates

	Current Rate	Proposed TOU Rates	Difference
Basic Service	$20.50	$20.50	$ -
Summer On-Peak Energy	$0.09159	$0.19838	$0.10679
Summer Off-Peak Energy	$0.09159	$0.06662	($0.02497)
Winter On-Peak Energy	$0.09118	$0.19838	$0.10720
Winter Off-Peak Energy	$0.09118	$0.06662	($0.02456)

LEVERAGE

WHAT IS MISSING?

A simple way for residential and small commercial businesses to sell power into the KUB distribution system as a fair price.

The perfect program would:

- Let you take advantage of the federal Investment Tax Credit (ITC)
- Encourage you to participate in the new TVA Green Connect solar installer quality program
- Help you qualify for the State of Tennessee as a Certified Green Energy Production Facility

TENNESSEE VALLEY SOLAR CONFERENCE +Storage

2020 AGENDA *(times are CDT)*	
Time	**Event**
9:00 a.m.	**Virtual Fireside** ***Facilitator:*** Chris Koczaja, TenneSEIA President Jeff Lyash, TVA President and CEO David Salyers, TDEC Commissioner, State of Tennessee
9:45 a.m.	**Panel One – Solar Opportunities in TVA** ***Facilitator:*** *Chris Hansen, VP, Origination & Renewables, TVA* RFP Process – Meagan Holman, TVA Green Invest – Jamie Bach, TVA Green Connect – Ethan Ogle, TVA
10:45 a.m.	**Break**
11:00 a.m.	**Panel Two – The LPC Solar Market and Contract Flexibility** ***Facilitator:*** David Callis, Tennessee Electric Cooperative Association (TECA) Betsey Kirk McCall, Seven State Power Company (7SPC) Mike Partin, *Sequachee Valley Electric Cooperative* (SVEC) Mike Bolin, Knoxville Utility Board (KUB) Brad Gibson, Middle Tennessee Electric Membership Corporation (MTEMC)

Invitation

Join us on October 7 for our Webinar

Special Partnership pricing

Promo Code: **PARTNER**

https://attendee.gotowebinar.com/register/7189451855717535760

Questions?

Gil Hough

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TenneSEIA
Tennessee Solar Energy Industries Association

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Cities, Buildings, Energy and Climate Change

Architects design with consideration of nature and the environment. Building energy use has a huge impact on the environment, which is under historically unprecedented stress from human activity.

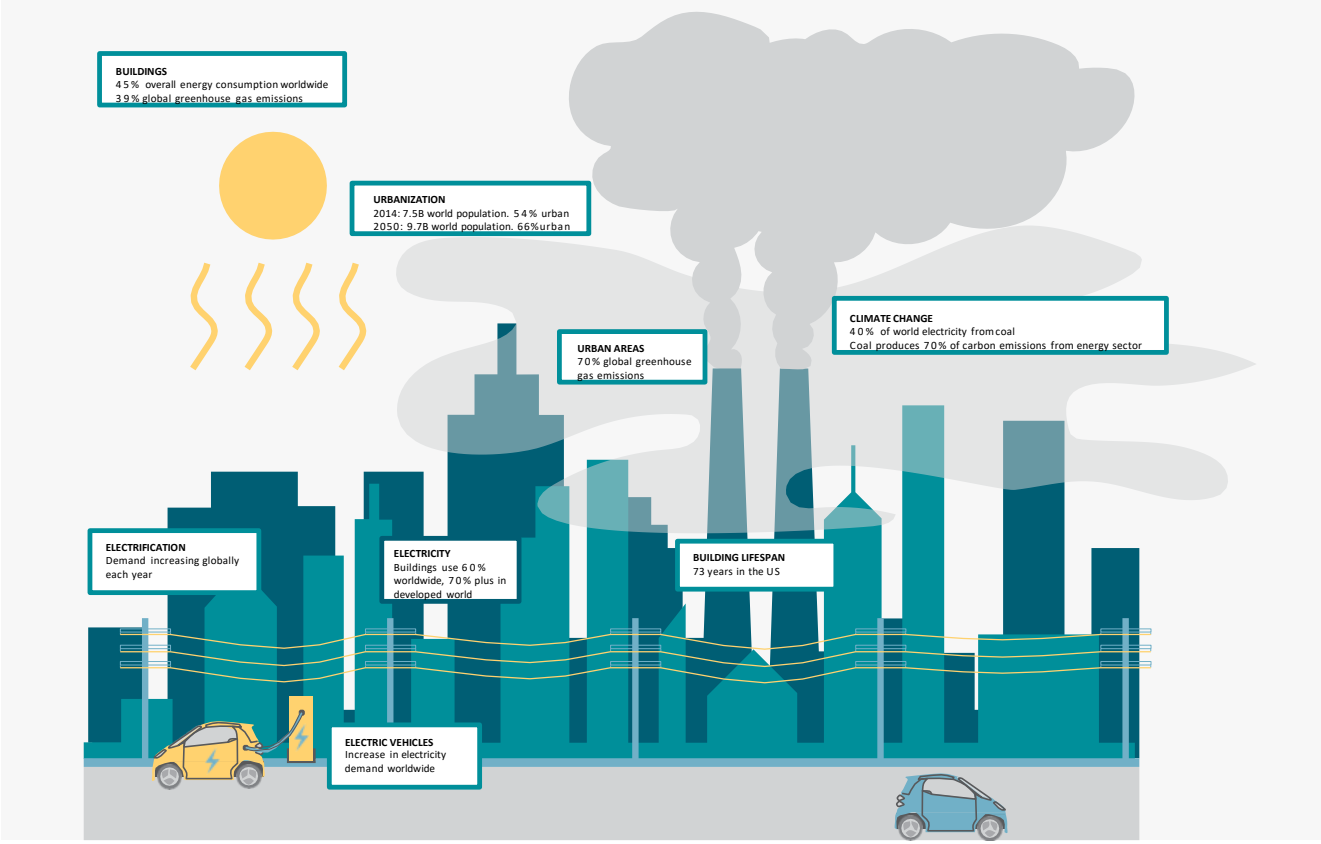


Image Credit: 'Architect's Guide to Building Performance' by AIA

AIA 2030 Commitment

One AIA initiative that promotes high performance building is the AIA 2030 Commitment, a voluntary initiative that prioritizes energy performance and provides guidance, tools, and knowledge sharing to participating firms so they can more easily work toward carbon neutral projects.. The mission of the AIA 2030 Commitment is to support the 2030 Challenge, which states that operations in all new buildings, developments, and major renovations shall be carbon neutral by the year 2030. The 2030 Challenge can be met by following these steps:

1. Establish an EUI baseline and target.
2. Apply low/no cost passive design strategies to achieve maximum energy efficiency.
3. Integrate energy efficient technology and systems.
4. Incorporate on-site and/or off-site renewable energy to meet the remaining energy demands.
5. Engage in iterative energy modelling throughout the entire design process to understand the interactive effects of various design decisions and to assess progress towards meeting the EUI target.

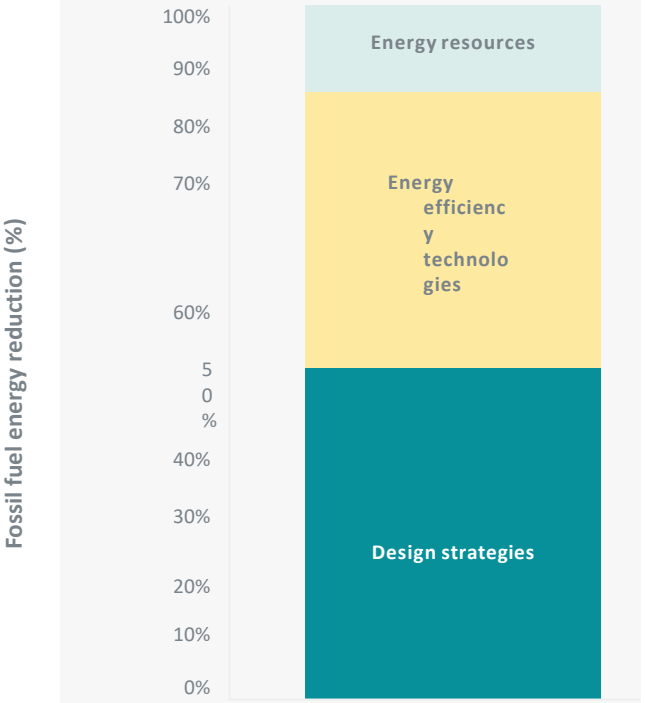
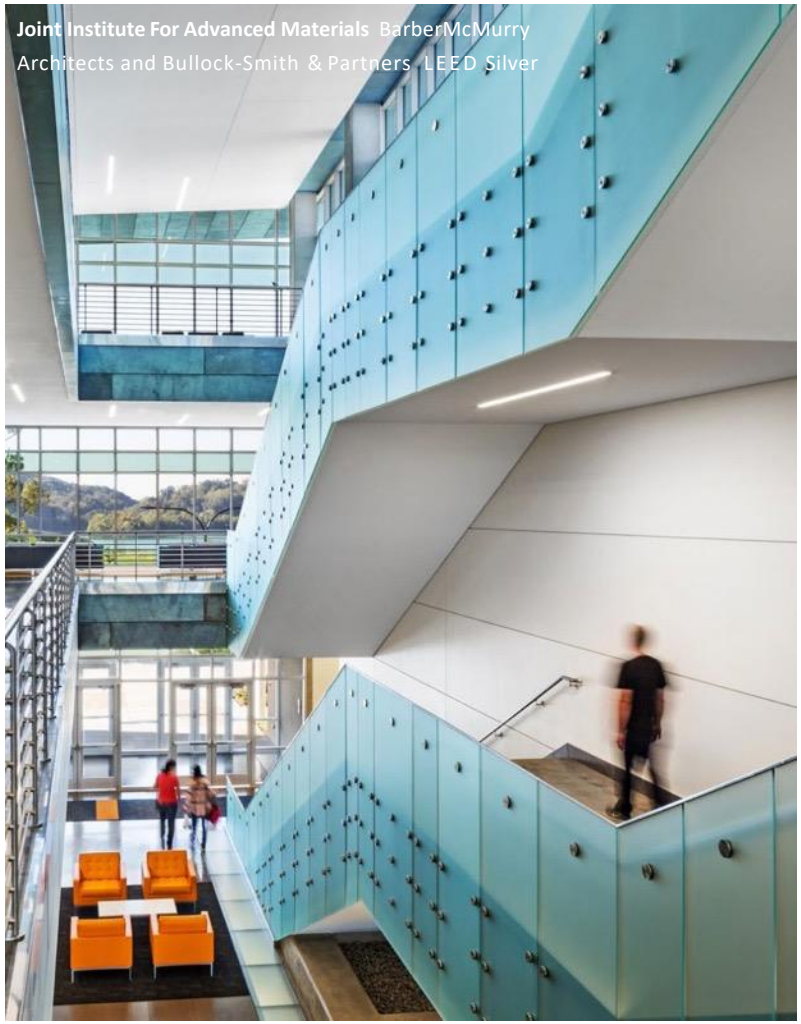


Image Credit: 'Architect's Guide to Building Performance' by AIA

Design + Energy Use

Design Strategies have the greatest impact on energy use, and architects have the greatest impact on design strategies in the design process.



AIA East Tennessee Priorities

In recognition of these responsibilities and to promote high performance buildings and renovations, AIA East Tennessee supports and advocates for the following:

- Developing policy recommendations that promote climate-sensitive design and adaptation for all new and existing buildings.
- Developing policy and regulations to incentivize significant reductions in operational and embodied carbon.
- Developing a comprehensive strategy for adopting regulations which promote high performance building, such as the ZERO code.

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OAK RIDGE National Laboratory

Climate Change and Building Energy impacts via Digital Twins

For: Mayor's Climate Council

Presented by:
Joshua New, Ph.D.,
C.E.M., PMP, CMVP, CSM, IREE
Senior R&D Staff
Oak Ridge National Laboratory

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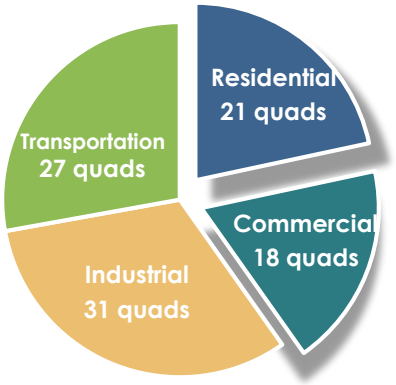
U.S. DEPARTMENT OF ENERGY

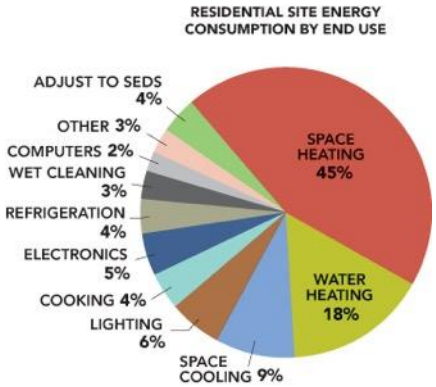
U.S. Energy and Buildings Overview

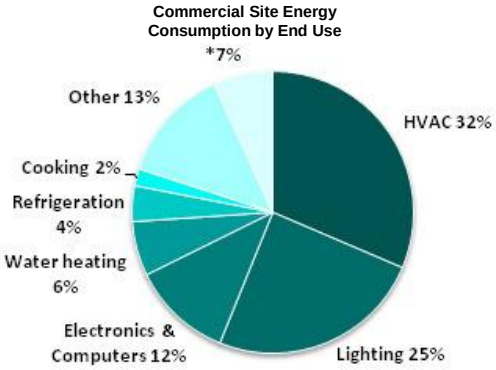


40% energy use
39% emissions

125 million buildings

$412 billion
in 2019 energy bills





Buildings consume 73% of the nation's electricity
80% of energy during peak hours

 # Buildings: 96% residential
Energy use: 54% residential

4% commercial
46% commercial

Goal of the DOE Building Technologies Office:
30% energy reduction per sq. ft.
by 2030 compared to 2010 baseline

Office of Electricity vision:
Harness innovation for a stronger, more resilient and reliable North American energy system while maintaining energy independence.

Building Energy Modeling – building descriptions + weather = estimated building energy consumption

Grid-interactive Efficient Buildings (GEB) Vision: integration and continuous optimization of DERs for the benefit of building owners, occupants, and the grid.

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ASHRAE Climate Zones – every U.S. county

- Climate zones based on 18+ years of quality data from 8,000+ met stations
- Most state building codes based on weather data from 1961-1990
- Redefining climate zones, include trends

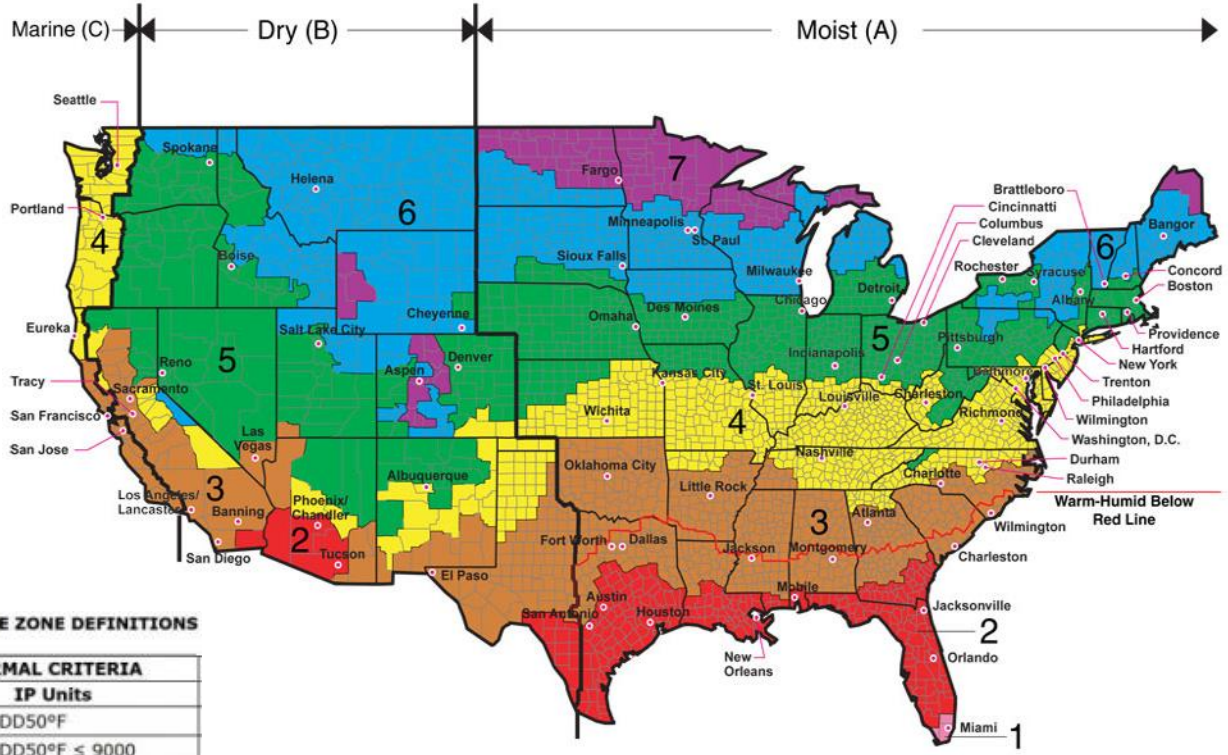

TABLE 301.3(2) INTERNATIONAL CLIMATE ZONE DEFINITIONS

ZONE NUMBER	THERMAL CRITERIA IP Units
1	9000 < CDD50°F
2	6300 < CDD50°F ≤ 9000
3A and 3B	4500 < CDD50°F ≤ 6300 AND HDD65°F ≤ 5400
4A and 4B	CDD50°F ≤ 4500 AND HDD65°F ≤ 5400
3C	HDD65°F ≤ 3600
4C	3600 < HDD65°F ≤ 5400
5	5400 < HDD65°F ≤ 7200
6	7200 < HDD65°F ≤ 9000
7	9000 < HDD65°F ≤ 12600
8	12600 < HDD65°F

Heating Degree Days:

$HDD = \sum(T_{base} - < T_i >)^+$

T_{base} = 18°C (65°F)

Cooling Degree Days:

$CDD = \sum(< T_i > - T_{base})^+$

T_{base} = 10°C (50°F)

Updated every 4 years (2021)
Climate zones are moving north

2017 - Climate Zone 0 (extremely hot): 10,800 < CDD 50°F
Int'l Energy Conservation Code (IECC) adopts for 2018 code

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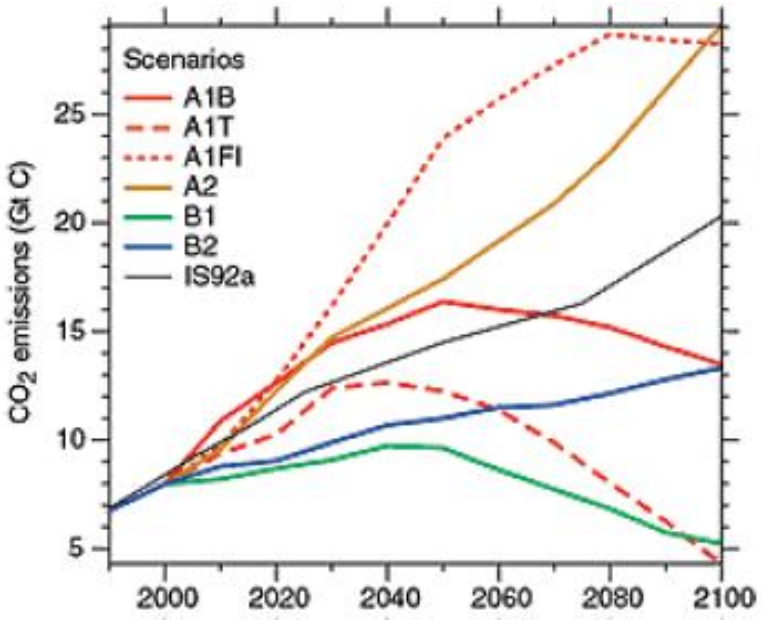
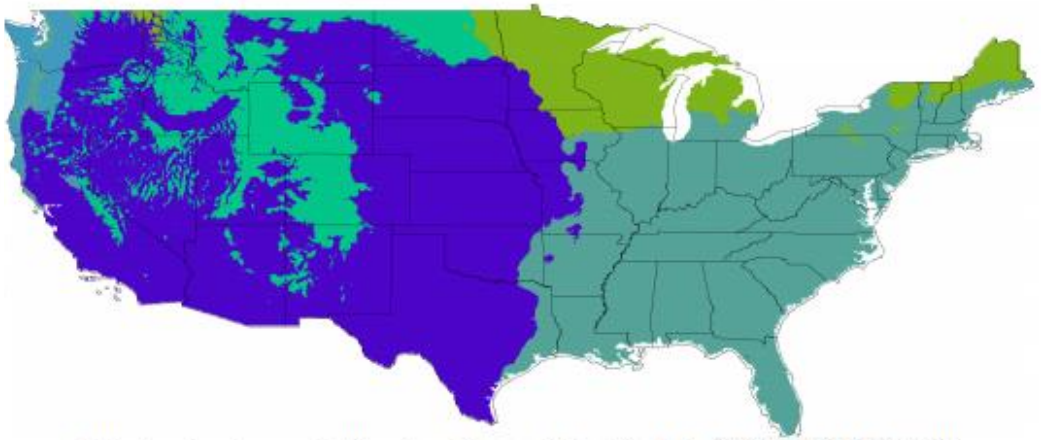
Climate Change Impacts

Contemporary Period

Clustering-based Climate Zones (K=5): HadGCM A1FI 2050





Clustering-based Climate Zones (K=5): HadGCM A1FI 2100

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Computational tools

Simulation Engine and Analysis Platform
U.S. Dept. of Energy
$100+M, 1995–?

EnergyPlus

OpenStudio

Free, open-source (GitHub), free support
100 – 2,000 improvements per building

Theta is the world's fastest buildings energy model (BEM) simulator

>500k building simulations in <1 hour

130M US buildings could be simulated in 2 weeks

8M simulations of DOE prototypes (270 TB)

ALCC Award
19M core-hours
June 2, 2020

Titan supercomputer

CPU Cores	Wall-clock Time (mm:ss)	Data Size	EnergyPlus Simulations
16	18:14	5 GB	64
32	18:19	11 GB	128
64	18:34	22 GB	256
128	18:22	44 GB	512
256	20:30	88 GB	1,024
16,384	26:11	5.6 TB	65,536
32,768	31:29	11.5 TB	131,072
65,536	44:52	23 TB	262,144
131,072	68:08	45 TB	524,288

Theta supercomputer

CPU Cores	Wall-clock Time (mm:ss)	Data Size	EnergyPlus Simulations
57,344	20:44	440 GB	229,376
114,688	28:20	880 GB	458,752

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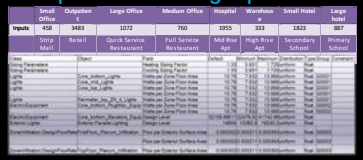
5-year vision

Digital Twin of every U.S. building in 2020

Methodology: Scalable compute, data, simulation, and empirical validation

1. Quantitatively rank most important building inputs

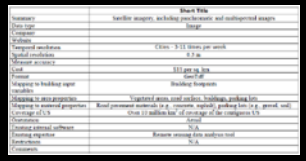


Sensitivity Analysis

2. Time on world's #1 fastest high-performance machines

Supercomputers

3. Identify and compare data sources for important inputs



Comparison Matrix

4. Establish partnerships and APIs for scalable data retrieval

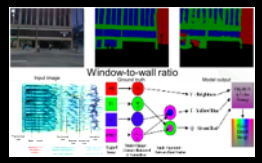
Satellite/Aerial Imagery

StreetView

LIDAR

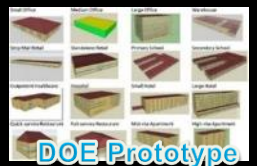
Databases

5. Algorithms to extract building properties



Computer Vision

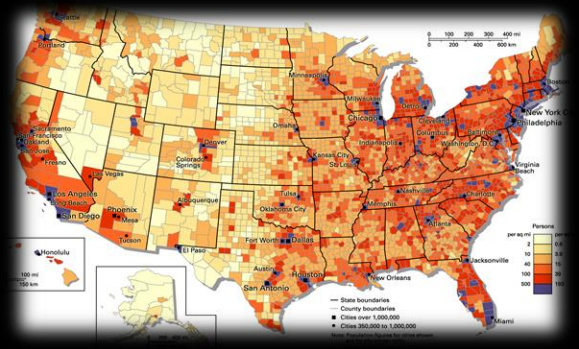
6. Create OpenStudio & EnergyPlus models



DOE Prototype Buildings

7. Make models freely available

Download BEM via street address



HPC Tools for Modeling and Simulation
Capturing building energy consumption

Demonstrate and stimulate opportunities toward a sustainable built environment

Use cases:

- City-scale energy impacts
  - Google's Environmental Insights Explorer
- Simulation-informed analysis design
  - AIA 2030 – BEM in 64% of projects
    - BEM 64% projects, 75% of gross ft^2
    - No-BEM: 41% better CBECS 2003
    - BEM is 51% better than
  - SmithGroup, Bentley Systems
- Sales/marketing leads
- Utility program formulation
- Resilience
- Automated financing
- Business model evaluation

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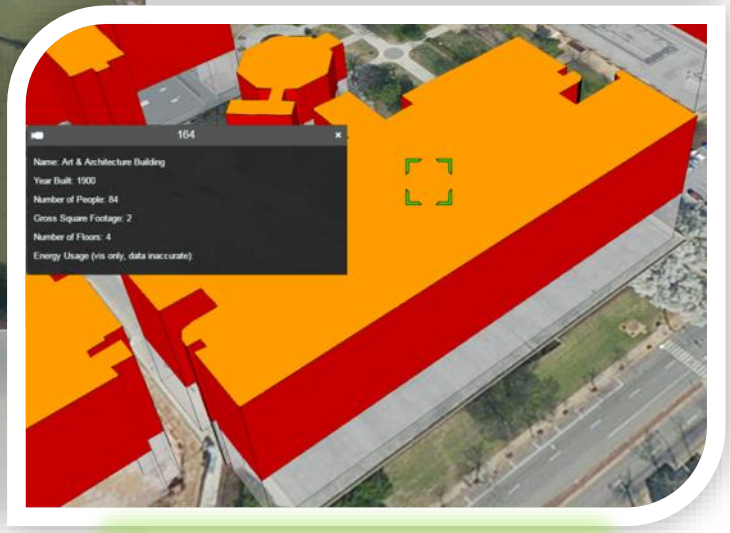
Digital Twin: UT (built in 2 days)



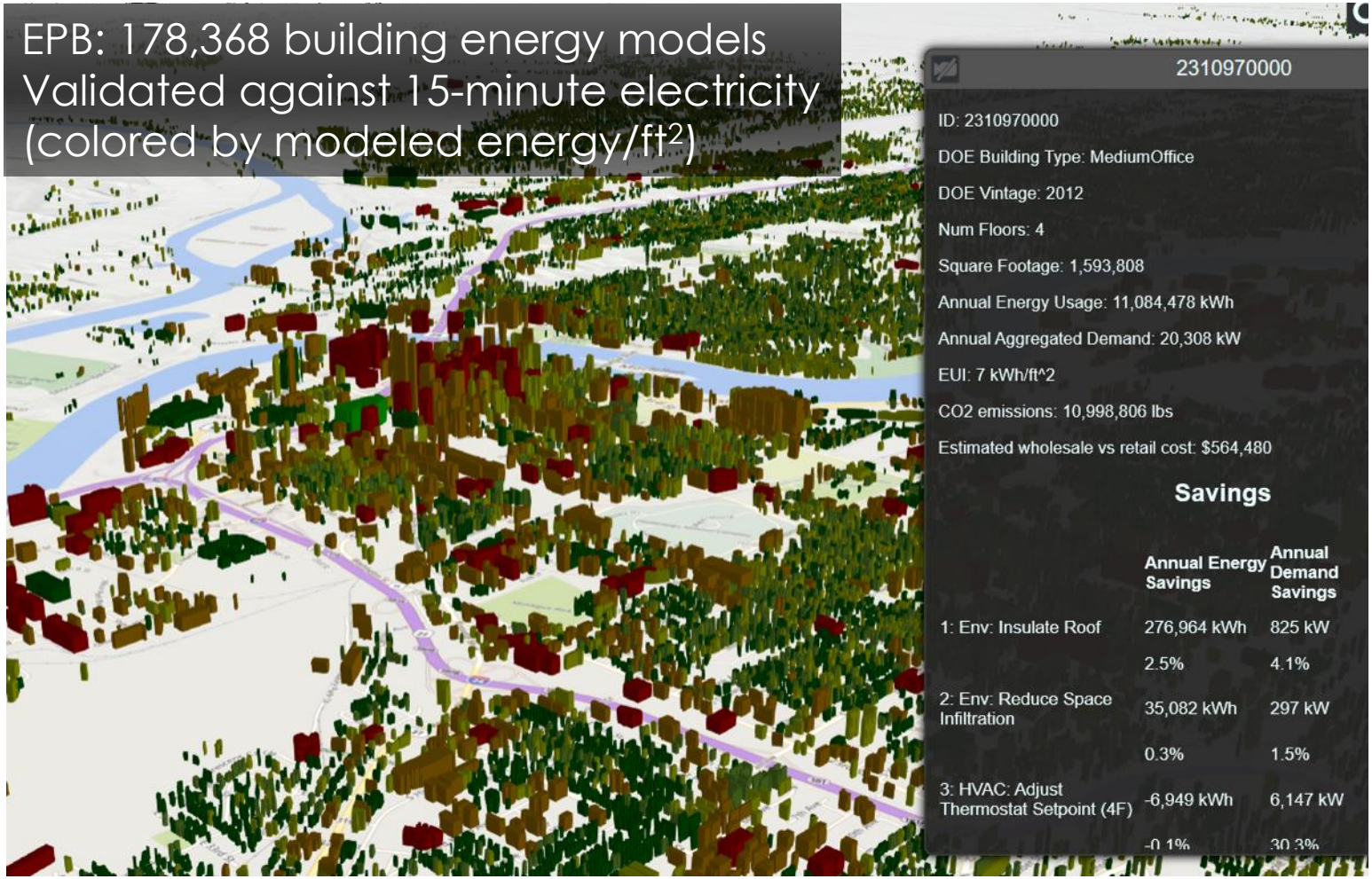
bit.ly/ut_buildings

OAK RIDGE National Laboratory | BUILDING TECHNOLOGIES RESEARCH AND INTEGRATION CENTER

Digital Twin: Energy, Demand, Emissions, $ Savings

Results: Digital Twin of a Utility (every building)

EPB: 178,368 building energy models
Validated against 15-minute electricity
(colored by modeled energy/ft^2)



http://bit.ly/virtual_epb

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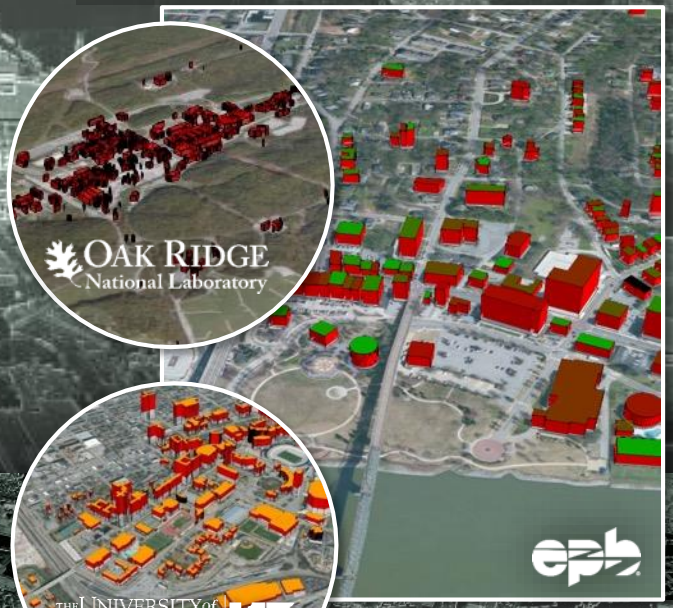
Discussion

HPC Tools for Modeling and Simulation
Capturing building energy consumption



Joshua New, Ph.D., CEM, PMP, CMVP, CSM
Subprogram manager for
Software Tools & Models
Building Technologies Research
and Integration Center (BTRIC)
Oak Ridge National Laboratory

newjr@ornl.gov


Break


Facilitated
Discussion

Facilitated Discussion Ground Rules

- Be respectful
- Discussion will be limited to to GHG mitigation strategies for energy & buildings – other topics will be pinned to the “Parking Lot”
- We are primarily looking to identify points of leverage for each strategy

General Reactions

- Are there specific strategies for which the City currently seems well positioned?
- Are there specific strategies for which private sector leadership and resources are better suited? Are there people on the MCC who can take a leadership role?
- What are the points of leverage for each strategy (existing infrastructure, market awareness, community buy-in)?

Create voluntary large commercial and multi-family energy upgrade program(s) (eg. incentives, technical assistance) that achieve deep energy savings (~25%+) in ~20%+ of large buildings

Enact market incentives (eg. zoning or financial) that achieve ~25%+ better energy performance than existing local code in new building space

Create voluntary home energy upgrade program(s) that will achieve deep energy savings (~25%+) in 20% of homes

Create voluntary home energy upgrade program(s) that will achieve moderate energy savings (~10%+) in 40% of homes

Create voluntary large commercial and multi-family energy upgrade program(s) (eg. incentives, technical assistance) that achieve moderate energy savings (~10%+) in ~50%+ of large buildings

Develop a local strategy and enact programs to drive thermal decarbonization/electrification (eg. replacement of fossil fuel-fired furnaces, boilers, and domestic hot water systems with electric heat pump technologies or other renewable options) of existing buildings over time

Establish a community-shared renewable energy program (eg. community solar) at a scale engaging ~5%+ of community members

Require and/or encourage large commercial buildings over 25,000 square feet to conduct audits and/or retro-commissioning

Develop/enhance programs that allow customers to purchase renewable energy through local utilities

Require and/or encourage large multi-family buildings over 10,000 square feet to conduct audits and/or retro-commissioning

Require large multi-family buildings to report their energy performance

Require large commercial buildings to report their energy performance

Adopt new ordinances or building codes to promote solar-ready construction in buildings over 10,000 square feet

Develop a building staff training program with large privately-owned commercial and multi-family buildings and/or require building staff be trained in energy efficiency best practices

Challenges / Barriers

- What resource challenges do we need to consider?
- Where does the investment need to come from?
- What time parameters should be considered?
- Who are the critical stakeholders?

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Opportunities

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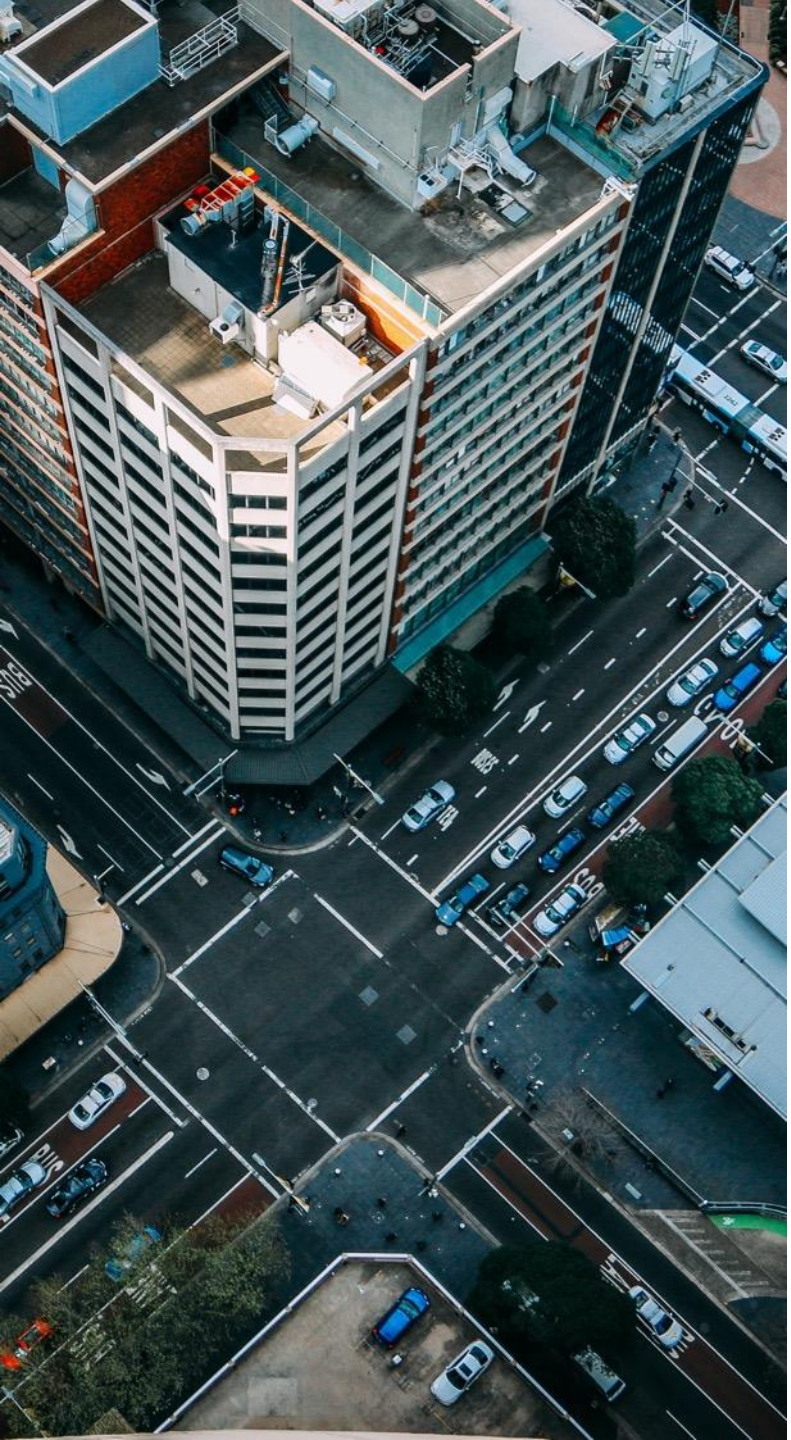
Wrap Up & Next Steps



Energy & Buildings Technical Working Group Meeting is scheduled for October 13 - 1:00-3:00 ET

*MCC members are encouraged to attend, but their participation is not required

Customer Satisfaction Survey

Thank you!

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